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Description

BACKGROUND OF THE INVENTION

(Field of the Invention)

The present invention relates to a piezo-electric vibrator pump in which suction and discharge of fluid are accomplished by the vibration of a piezo-electric vibrator formed of a piezo-electric film of a monolayer or laminate, and more particularly to a piezo-electric vibrator and a piezo-electric vibrator with an invertor of high efficiency suction non-return valve can be operated promptly according to the vibration generated by the frequency voltage produced when it is driven by an alternate current supply.

(Description of the Prior Art)

Referring to the usual piezo-electirc vibrator pump shown in Figure 4, the usual piezo-electric pump comprises a piezo-electric vibrator 2 mounted in a casing 1 having a peripheral part secured to casing 1 within casing 1. The piezo-electric vibrator 2 is formed of two laminated piezo-electric layers 9,9 and electrode 3 inserted between the two piezo-electric layers 9,9, and electrodes 4,4 laminated on both sides of laminated two piezo-electric layers 9,9. Lead wires 11,12 are connected to the electrodes 3,4. The piezo-electric vibrator pump is provided with a suction non-return valve 5 (check valve)and a discharge non-return valve 6. An alternate current voltage e is applied between the electrodes 3,4 of said piezo-electric vibrator 2 through lead wires 11,12 which results in vibration of said piezo-electric vibrator causing fluid to be sucked through the suction non-return valve 5 and discharged through the discharge non-return valve 6 with the vibration of the piezo-electric vibrator.

However, because of direct attachment of the piezo-electric vibrator 2 to the casing, the usual pump has many disadvantages. The vibration of the piezo-electric vibrator 2 is restricted so that the amplitude of the piezo-electric viblator 2 becomes smaller, its performance is lower, its insulation characteristic is inferior, noise occurs due to the vibration of the piezo-electric vibrator, and in some cases stresses are imposed on the parts of the piezo-electric vibrator attached to the casing to such an extent that the piezo-electric vibrator may be broken.

Further, in the usual construction of a piezo-electric vibrator not coated with an elastic layer, piezo-electric vibrator 2, secured to a pump casing 1, is vibrated as shown in Figure 4. That is, there is a scarcely displaced part at the peripheral part of the piezo-electric vibrator so that a dead space is formed, resulting in lower gas suction-discharge capability and lower liquid selfsuction. In order to remove such a dead space, it is conceived to lessen the clearance between the piezo-electric vibrator 2 and an inner surface of the casing 1. However, there is the possibility that the collision of the piezo-electric vibrator with the casing 1 can occur resulting in the breakdown of the piezo-electric vibrator.

US-A-3.657.930 discloses a pump using Bimorph-Piezoelectric driven by crystal Diaphragm added AC Voltage. However, opposite faces of the Piezoelectric diaphragm are not covered by elastic elastomer. JP-A-60159387 discloses driving system of pump in which unimorphic vibration element is attached to an insulating packing comprised of a sheet of urethane resin, rubber etc., and the insulating packing is interposed between a vibration element and the wall of a pressure chamber for insulation. A recess is formed at the wall of pressurizing the chamber A so as to form a vibration chamber. The chamber is defined by insulating packing between the chamber and an unimorphic vibration element which is attached to the insulating packing for vibration the insulation packing for sucking and discharging. Although the packing is called insulating packing, this packing acts as diaphragm packing plate.

(Brief Summary of the Invention)

Accordingly, it is an object of the present invention to provide a piezo-electric vibrator pump having an improved insulation characteristic and higher fluid suction-discharge capability to improve the pump performance, and in which there is no possibility that the piezo-electric vibrator may be broken prolonging that its service life the problem of generation of noise is also solved.

The above object of the present invention is attained, according to the invention, by a piezo-electric vibrator pump in which a piezo-electric vibrator 2 is mounted in a casing 1 whose peripheral part is secured to and within the casing 1. The vibrator pump has a suction non-return valve 5 through which fluid is sucked from a suction line, and a discharge non-return valve 6 through which fluid is discharged to a discharge line by means of the piezo-electric vibrator 2 vibrated by applying an alternative current voltage e between

electrodes 3,4 of the piezo-electric vibrator. The piezo-electric vibrator pump has both sides of the piezo-electric vibrator 2 coated with an elastic elastomer layer 10.

In the usual piezo-electric vibrator not coated with elastic elastomer, when suction and discharge of fluid are performed by vibrating the piezo-electric vibrator 2, the are disadvantages are that the amplitude thereof is small, the performance is inferior, noise occurs, and stresses are imposed on the fixed part of the vibrator so that the vibrator may be broken. On the other hand, in a piezo-electric vibrator according to the present invention which is coated with elastic elastomer layer 10, there are the advantages of layer amplitude and higher performance because the elastic elastomer layer coating the vibrator 2 is secured to and within the casing 1 so that the vibrator is suspended in the elastic elastomer. Insulation characteristics are excellent because fluid does not come directly in contact with the piezo-electric vibrator, noise is lower, and stresses are not directly imposed on the piezo-electric vibrator. Therefore the piezo-electric vibrator 2 is difficult to break because the piezo-electric vibrator 2 is not secured directly to the casing.

Further, the deformation of the elastic elastomer along the pump casing 1 results in a remarkably reduced clearance, preventing the piezo-electric vibrator from breaking by colliding with the casing. Therefor, the self-suction ability of the piezo-electric vibrator pump is improved.

(Brief Description of the Drawings)

In the drawings:

Figures 1 and 2 are sectional views of piezo-electric vibrators for examples according to the present invention, respectively;

Figure 3 is a circuit diagram showing one example of an inverter with which a piezo-electric vibrator pump according to the present invention is provided; and

Figure 4 is a sectional view showing one example of a prior art usual pump.

The follwing example according to the present invention is explained in connection with the accompanying drawings.

(Detailed Description of the invention)

The piezo-electric vibrator 2 may be a piezo-electric vibrator such as a piezo-electric vibrator of laminate type in which a piezo-electric bodies are laminated on both outer sides of a shim as of phosphor bronze, or a piezo-electric vibrator or of monolayer type as ceramic, polymer piezo-electric materials, which is provided with thin film electrodes 3,4.

Further both sides of the piezo-electric vibrator 2, including its part held in the casing 1, is covered with the elastic elastomer having modulus of londitudinal elasticity of less than 5×10^8 dyn/cm^2, preferably of less than 2.0×10^8 dyn/cm^2, more preferably 1.5×10^8 dyn/cm^2.

As the elastomer, elastic material can be used such as silicone rubber, urethane rubber, natural rubber, SBR(styrenebutadiene rubber), cloroprene rubber, Neoprene(Trade mark of du Pont for cloroprene rubber), NBR(nitrile rubber), SBS(styrenebutadienestyrene copolymer), hydrogenated SBR, fluorosilicone rubber, fluoroelastomer, EPR(ethylene propylene rubber), ethylene vinylacetate copolymer or the like.

Under the condition that the suction and discharge of fluid is performed with the vibration of the piezo-electric vibrator 2 to which A C voltage e is applied, coating the piezo-electric vibrator 2 with the elastic elastomer 10 results in the improvement of the lifetime and the perfofmance of the pump and the increase of uses of the pump.

When the piezo-electric vibrator 2 is not covered with the elestic elestomer 10, there are disadvantages that the insuration characteristic is worse, because of the snail amplitude the performance of the pump is lower, and because the piezo-electric vibrator 2 is fixed direcly to the casing 1, stresses is imposed on the supported part of the piezo-electric vibrator so that the piezo-electric vibrator 2 break easily and the noise is made.

However, when the piezo-electric vibrator is coated with the elastic elastomer 10, insulation characteristics improve, and the amplitude of the piezo-electric vibrator increases because the piezo-elastic vibrator 2 is suspended in the elastic elastomer 10. Thus pump performance is improved. According to the invention, the piezo-electric vibrator 2 is not fixed directry to casing 1, but elastic elastomer 10 is fixed to the casing 1, stresses being difficult to impose on the supported part of the elastomer 10 by the casing 1. Therefore, the piezo-elastic vibrator will be not broken, and noise will be difficult to make.

Further, it becomes possible to flow many sorts of fluid, by laminating many types of plastic films on the elastic elastomer 10 with which the piezo-electric vibrator 2 is covered.

In order to demonstrate the effect of the pump according to the invention experiments were made comparing an example of the piezo-electric vibrator coated with the elastomer according to the invention with a comparison of the piezo-electric vibrator which is conventionally not coated, under the same conditions with respect to self-suction ability, pressure, and flow. The results are shown in the following table:

	Self-suction ability(mm)		Pressure (kg/cm^2)		Flow(ml/min)	
	liquid	gas	liquid	gas	liquid	gas
Comparison	50	-	0.05	0.02	80	500
Example	900	-	0.20	0.11	400	1000

From the results of the experiment, it is obvious that pump performance is improved by covering the piezo-electric vibrator 2 with elastomer.

As above-mentioned, the pump according to the invention has advantages of improved insulation characteristics, improved suction and discharge ability of fluid so that pump performance is improved. There is no danger of the piezo-electric vibrator being broken because stress is difficult to impose on the supported part of the piezo-electric vibrator by the casing, the lifetime can be lengthend, and also the problem of noise can be almost dissolved.

According to the invention, plural piezo-electric vibrators of monolayer type or laminate type may be used and insulating elastomer film(s) may be inserted between the plural piezo-electric vibrators.

Figures 1 and 2 are sectional views respectively showing two piezo-electric vibrators in which an elastic elastomer film 17 is inserted between the laminated piezo-electric vibrators, and a laminate of three piezo-electric vibrators in which two elastic vibrators, with electrodes 3, 4 of respective laminates of piezo-electric vibrators 2 being connected in parallel with lead wires. Liquid-impermeable film 18 is laminated on the surface of the elastomer 10 with which the piezo-electric vibrator 2 is covered, and connecting part 19 is for connecting electrodes 4, 4 of the respective piezo-electric vibrator 2.

As elastomer films 17, elastic materials such as elastic rubbers, plastics, metals or the like. Preferably an elastic material with a coefficient of thermal conductivity as high as possible is applied as elastomer films 17 with a view to facilitating cooling of the piezo-electric vibrator 2. However, in the laminate of two piezo-electric vibrators(Figure 1), the radiation of the piezo-electric vibrator 2 can be neglected as one side of the piezo-electric vibrator 2 is in contact with the elastomer 10.

The thickness of the elastomer film is about 0.1 - 5 mm, and preferably about 0.3 - 2 mm.

The phases of A C voltage e applied between electrodes 3, 4 of the respective piezo-electric vibrators are the same as the electrodes 3, 4 of the respective vibrators are connected in parallel with lead wires so that the function and effect of the pump can be attained in the same manner as in the above mentioned first example. However, when laminates of piezo-electric vibrators 2 over two layers are used, higher pump performance can be attained.

It is preferable to use conductive material as the elastomer film 17, because film 17 serves both as the elastic material and as the electric connection between respective piezo-electric vibrators 2.

When the laminate of plural piezo-electric vibrators 2 are laminated with interposed elastomer film(s) they are oscillated up and down in the direction perpendicular to the surface of the respective piezo-electric vibrator 2. In this case, it is necessary to freely bend elastomer(s) interposed between each respective piezo-electric vibrator 2 and adhered to each respective piezo-electric vibrators 2 in such a way that the elastomer film(s) 17 can not prevent the piezo-electric vibrator 2 from bending. Further, it is necessary to avoid deforming the elastomer film(s) in the direction of the thickness in order to effectively take out the displacement and the forces generated in respsctive piezo-electric vibrator 2 to the outer areas of the elements.

For this purpose, it is desirable that the both sides of the elastomer(s) 17 are provided with many ribs which intersect either lengthwise or crosswise.

Further, it is possible to make the elastomer film(s) serve both as the transmitting means of stress generated in respective elastomer film(s) and as the electric connection between electrodes of the piezo-electric vibrators, by giving conductivity to the elastomer film(s) by mixing metal powder such as aluminium, or conductive carbon black with the elastomer material.

The pump according to the invention can be driven with commercial electric source. When the commercial electric source is used the pump driving force can be controlled to control the discharge of fluid by controlling the voltage of the electric source through a transformer or variable resistance.

Further, the pump according to the invention can be driven by a D C electric source as occasion demands. For example when the pump according to the invention is applied to a portable apparatus the pump according to the invention can be driven with the following inverter.

Figure 3 is a circuit diagram showing an example of an inverter driving the pump according to the invention. Constant-voltage circuit 26 for transforming the voltage V_1 of the D C electric source input to the constant-voltage circuit into constant-voltage (3 terminal regulator), can be omitted. Oscillation circuit 27 to which D C voltage V is output with oscillations according to the time constant of capacitor Cx and resistor (CR =VRx +Rx) with the following frequency:

$$f = \frac{1}{2\,Cx\,(\,VRx + Rx\,)} \quad .$$

In the example shown in Figure 3, a triangular wave is oscillated and triangular wave voltage V_Δ is output. The oscillation circuit 27 comprises a square wave generating division circuit including a comparator IC element IC_1 and resistors R_3, R_4, a triangular wave genarating division circuit including a capacitor Cx transforming square wave voltage output from square wave generating division circuit into a triangular wave voltage, a resistor R, and a comparator IC element IC_2. The triangular wave generating division circuit is called a Miller integrating circuit. In this example, the triangular wave generating division is designed so that oscillation frequency f can be altered by changing the resistance value of a variable resistor VRx. Resistors R_1, R_2 are for dividing D C voltage V_1.

The potential dividing point (connecting point) of resistor R_1, R_2 is connected to a negative terminal of the comparator IC element IC_1 and the positive terminal of the comparator IC element IC_2. The resistor R_4 is connected between the positive terminal of and the output terminal of the comparator IC element IC_1, while the resistor R_3 is connected between the positive terminal and the output terminal of the comparator IC element IC_2.

The series circuits of the variable resistor VRx and the resistor Rx are connected between the output terminal of the IC element IC_1 and the negative terminal of the IC element IC_2, while the capacitor Cx is connected between the negative terminal and the output of the IC element IC_2.

Therefore the square wave generating division of the oscillating circuit 27 is operated with the voltage of capacitor Cx, thereby the square wave voltage is output from the output terminal of IC element IC_1, the square wave voltage is input to the triangular wave generating division circuit so that triangular wave voltages are integrated, and the triangular wave voltageV_Δ is output from the output terminal of the IC element IC_2.

Numeral 28 designates a driving circuit receiving the output of the oscillating circuit 17 and from which after the quiescent period t_1, two operating signals Vd_1, Vd_2 with operating times different from each other are output. The driving circuit comprises a comparator IC element IC_3, which operates during the period of a positive wave of the triangular wave voltage V_Δ, a comparator IC element IC_4 which operates during the period of negative wave of the triangular wave wave voltage V, resistors R_5, R_6, a variable resistor VR for adjusting the pulse quiescent period and diodes D_1, D_2.

The series circuit of the resistor R_5, the variable resistor VR_1 and the resistor R_6 is connected between the DC voltage line and the earth line. The connecting point of the resistor R_5 and the resistor R_4 is connected to the positive terminal of the IC element IC_4. The positive terminal of the IC element IC_3 and the negative terminal of the IC element IC_4 are connected with each other and are connected to the output terminal of the IC element IC_2 of the triangular wave oscilating circuit 17. Diodes D_1, D_2 anode side is connected to the output terminals of the IC elements IC_3, IC_4, respectively.

Pulse generating circuit 29 receives the output from IC elements IC_3, IC_4 to convert DC voltage V_2 into positive and negative pulse voltages $\pm$ Vp. The pulse generating circuit 29 comprises the bridge circuit 30 including npn, pnp transistors Tr_1, Tr_2 respectively on oposing lines and npn, pnp transistors Tr_3, Tr_4 respectively on other opposing lines. Transistors Tr_1, Tr_2 and transistors Tr_3,Tr_4 are alternately switched on and off, respectively. The bridge circuit 30 is designed, as hereinafter described in detail so that positive and negative pulse voltages $\pm$ Vp having a quiescent period t_1 can be alternately obtained between the output terminals of the bridge circuit 30 by applying DC voltage V_2 between the voltage terminals of the bridge circuit 30.

That is, resistors R_{14}, R_{15} are connected between the base and emitter of npn transistor Tr_1 on one line of the opposing lines, and between the base and emitter of npn transistor Tr_3 on one line of the other

opposing lines, respectively. The respective emitters are connected to earth. Resistors R_8, R_7 are connected between the bases of the respective transistors Tr_1, Tr_2 and the diodes D_1, D_2, while diodes D_5, D_6 are connected between the collectors and the emitters of transistors Tr_3 and Tr_1.

Resistors R_{11}, R_{12} are connected between base and emitter of the npn transistor Tr_2 on the other line of the opposing lines and between base and emitter of the pnp transistor Tr_4 on the other line of yet another opposing lines, respectively. The respective bases are connected to voltage terminal V_2 through resistors R_{11},R_{12}. Resistors R_9, R_{10} are connected between the respective bases and the collectors of the npn transistors Tr_1, Tr_3, while diodes D_3, D_4 are connected between the respective collectors and the respective voltage terminals V_2.

Further, the collector of the npn transistor Tr_1 on one of the opposing lines is connected to the collector of the other pnp transistor Tr_4, and the collector of the npn transistor Tr_3 of one line of another opposing two lines is connected to the collector of the other pnp transistor Tr_2.

Therefore, in pulse generating circuits 29, during a positive slope of triangular voltage V_Δ the comparator IC element IC_3 functive to produce signal Vd_1 which is sent to earth (ground) through the diode D_1, the resistor R_8, and the resistor R_{14}, the npn transistor Tr_1 change to an on-state with the signal on resistor R_{14}, thus electric current is sent from voltage terminal V_2 to earth through the resistors R_{11}, R_9 and the collector of the npn transistor Tr_1, changing the pnp transistor Tr_2 to an on-state by the voltage on the resistor R_{11}. Thereby, positive pulse voltage $+Vp$ is obtained from the output terminals 0 which is connected to the collector of the pnp transistor Tr_2.

Further, during the negative slope of thee triangular wave voltage V_Δ the comparator IC element IC_4 functive to produce signal Vd_2 qwhich is sent to the earth through the diode D_2, the resistor R_7, and R_{13}. The npn transistor Tr_3 is changed to an on-state, thereby electric current is sent from the voltage terminal V_2 to the earth through the resistors R_{12}, and R_{10}, and the collector and the emitter of npn transistor Tr_3. The pnp transistor Tr_4 is changed to an on-state by the voltage on the resistor R_{12}. Thereby, negative pulse voltage-Vp can be obtained at the output terminals 0 connected to the collector of the pnp transistor Tr_4.

The positive and negative pulse voltage $\pm Vp$ can be freely changed by changing the DC voltage V_1. Thus, by connecting the output terminal to the piezo-electric vibrator pump as shown in Figures 1 and 2, it is possible to work the pump with the positive and negative pulse voltage$\pm Vp$ with voltage values adjusted to the pump. It is not necessary to elaborate but the positive and negative pulse voltage $\pm Vp$ can be held constant by holding the input constant.

The oscillation frequency of the triangular wave voltageV_Δ can be freely changed by changing the value of the variable resistor VRx. Further the triangular wave voltage V_Δ can be converted into a sine wave voltage by passing the positive and negative pulse voltages $\pm Vp$ generated at the output terminals of the pulse generating circuit 29 through a filter.

It being obvious from the hereinabove description, the following is possible, according to the invention

(1) the positive and negative pulse voltage DC output voltages $\pm Vp$ can be freely changed by changing the voltage of the DC power source (DC input voltage) V_1, thus the piezo-electric vibrator pump can be operated:

(2) the positive and negative pulse voltages $\pm Vp$ can be held constant by stabilizing the DC power source, thus the operation of the piezo-electric vibrator pump can be stabilized;

(3) the output frequency adjusted for the piezo-electric vibrator pump can be set by changing the time constant and the oscillation frequency, therefore the frequency adjustment for the piezo-electric vibrator pump can be made so that maximum efficiency is achieved.

(4) the piezo-electric vibrator pump can be operated with maximum electric power rather than with a conventional sine wave output voltage as positive and negative pulse voltages$\pm Vp$ can be obtained;

(5) the invertor can be simple and smaller and of low-cost construction as a switching element with a gate is not used;

(6) the power consumption can be reduced and accidents almost eliminated as compared with the conventional device in which an output voltage is changed as the positive and negative pulse voltages $\pm Vp$ are changed by changing the DC input voltage V_1; and

(7) on-off states of the npn transistors and pnp transistors Tr_1, Tr_2, Tr_3, and Tr_4 can be positively switched on and off even if the frequency and switching speed becomes higher with the two output operation signals Vd_1, Vd_2 with the pulse quiescent period t_1 of the driving circuit 28 to which the output triangular wave voltage V_Δ of the triangular wave oscillation circuit 27 is input and from which two operation signal Vd_1, Vd_2 whose operating points are different from each other are output after the quiescent period t_1. Therefore, the four transistors are not at all, if transiently, short-circuited and there is no possibility of overheating damage, and also the pump can be operated with alternately output positive and negative pulse voltages$\pm Vp$ with a pulse quiescent period t_1 from the output terminal.

From the hereinabove recited reason, the above-mentioned invertor is suitable for driving an electric power source for a piezo -electric vibrator pump, and therefore, the piezo-electric vibrator pump itself with the invertor according to the invention.

Claims

1. A piezo-electric vibrator pump comprising adjacent piezo-electric vibrators (2) mounted in a casing (1) having a peripheral part secured to a portion of said casing, a suction non-return valve (5) through which fluid is sucked from a suction line (7) and a discharge non-return valve (6) through which the fluid is discharged from a discharge line (8) by means of the piezo-electric vibrators vibrated by applying an alternative current voltage between electrodes of said piezo-electric vibrators, said suction and discharge non-return valves (5, 6) both being in said casing wall and on the same side of said piezo-electric vibrators, characterized in that the piezo-electric vibrators are coated on both sides with elastic elastomer layers (10, 17) of 1.0 to 5.0 mm thickness, having a modulus of longitudinal elasticity of less than 5 x 10^8 dynes/cm^2, whereby those elastic elastomer layers (17) which lie between adjacent vibrators (2) are conductive.

2. A piezo-electric vibrator pump as claimed in claim 1 wherein a liquid-impermeable film (18) is laminated on the surface of the elastic elastomer (10).

3. A piezo-electric vibrator pump according to claims 1 or 2 wherein the elastomer layer comprises an elastomer selected from the group consisting of silicone rubber, urethane rubber, Neoprene, NBR, SBR, chloroprene, silicone fluoride rubber, and ethyrene propyrene rubber.

4. A piezo-electric vibrator pump according to one of claims 1 to 3 wherein said suction line (7) and said discharge line (8) are each provided with a surge tank (13,14) having a space (15,16) at a respective upper part near said suction non-return valve (5) and said discharge non-return valve (6) respectively.

5. A piezo-electric vibrator pump according to claim 1 in which said piezo-electric vibrator pump includes an inverter having an oscillating circuit (27) receiving a direct current input so that the oscillation at a given frequency can be produced and from which a wave form voltage is output, a drive circuit (28) receiving an output from said oscillating circuit (27) and from which two operating signals having different operating points respectively are input at intervals of a quiescent period term and a pulse generation circuit (29) having positive and negative pulse voltages are alternately generated according to two operating signals output from said drive (28) said piezo-electric vibrator pump being driven by the output of said inverter.

6. A piezo-electric vibrator pump according to claim 5 including an inverter in which said pulse generating circuit (29) includes a bridge circuit (30), said bridge circuit (30) comprises a npn transistor and a pnp transistor arranged on two opposed sides respectively and a second npn transistor and pnp transistor arranged on opposite sides respectively wherein said npn transistors and said pnp transistors on respective opposite sides are connected so that said bridge circuit is formed having said npn transistors and pnp transistors alternately changed to on and off states, said two operating signals being applied to the two input terminals of said bridge circuit respectively, whereby a direct current is applied between the voltage terminals thereof and plus and minus pulse voltages with a pulse quiescent period is alternately obtained from the output terminals thereof, the output of said inverter being applied between electrodes of said piezo-electric vibrator.

Patentansprüche

1. Piezoelektrische Vibrator-Pumpe mit benachbart angeordneten, in einem Gehäuse (1) befestigten, piezoelektrischen Vibratoren (2), die mit einem Umfangsteil an einem Teil des besagten Gehäuses befestigt sind, mit einem Einweg-Ansaugventil (5), durch welches Flüssigkeit aus einer Saugleitung (7) angesaugt wird sowie einem Einweg-Entleerventil (6), durch welches die Flüssigkeit in eine Abflußleitung (8) mittels der piezoelektrischen Vibratoren, die durch Anlegen einer Wechselspannung zwischen Elektroden der besagten piezoelektrischen Vibratoren in Vibration versetzt werden, entleert wird, wobei die Einweg-Saug- und Entleerventile (5, 6) beide in besagter Gehäusewandung und auf der gleichen Seite der besagten piezoelektrischen Vibratoren angeordnet sind, dadurch gekennzeichnet, daß

die piezoelektrischen Vibratoren auf beiden Seiten mit elastischen Elastomer-Schichten (10, 17) von 1,0 bis 5,0 mm Dicke beschichtet sind, die Längselastizitätsmodule von weniger als 5 x 10^8 Dynes/cm^2 aufweisen, wobei diejenigen elastischen Elastomer-Schichten (17), die zwischen benachbarten Vibratoren (2) liegen, leitend sind.

2. Piezoelektrische Vibrator-Pumpe nach Anspruch 1, dadurch gekennzeichnet, daß auf der Oberseite des elastischen Elastomers (10) ein flüssigkeitsundurchlässiger Film (18) auflaminiert ist.

3. Piezoelektrische Vibrator-Pumpe nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Elastomerschicht ein Elastomer enthält, das aus der Gruppe ausgewählt ist, die aus Silikongummi, Urethangummi, Neopren, NBR, SBR, Chloropren, Silikonfluoridgummi und Ethylen-Propylen-Gummi besteht.

4. Piezoelektrische Vibrator-Pumpe nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß besagte Saugleitung (7) und besagte Entleerleitung (8) jeweils mit einem Druckausgleichsbehälter (13, 14) versehen sind, die einen Raum (15, 16) in einem entsprechend oberen Teil in der Nähe des besagten Einweg-Saugventils (5) bzw. des besagten Einweg-Entleerventils (6) aufweisen.

5. Piezoelektrische Vibrator-Pumpe nach Anspruch 1, dadurch gekennzeichnet, daß sie einen Inverter umfaßt, der einen Schwingkreis (27) zur Aufnahme eines Gleichstromeingangs aufweist, so daß eine Schwingung mit vorgegebener Frequenz erzeugt werden kann und von dem eine Wellenformspannung ausgeht, daß sie einen Treiberkreis (28) umfaßt, der das Ausgangssignal des besagten Schwingkreises (27) empfängt und von dem zwei Betriebssignale mit entsprechend unterschiedlichen Betriebspunkten in Intervallen einer Ruheperiode ausgehen und daß sie eine Pulserzeugungseinheit (29) mit positiven und negativen Pulsspannungen umfaßt, die abwechselnd entsprechend den zwei Betriebssignalen, die von besagtem Treiber (28) ausgehen, erzeugt werden, wobei besagte piezoelektrische Vibrator-Pumpe über den Ausgang des besagten Inverters betrieben wird.

6. Piezoelektrische Vibrator-Pumpe nach Anspruch 5 mit einem Inverter dadurch gekennzeichnet, daß besagter Pulserzeugungskreis (29) eine Brückenschaltung (30) umfaßt, wobei die Brückenschaltung (30) wiederum einen npn- und einen pnp-Transistor umfaßt, die auf entsprechend gegenüberliegenden Seiten angeordnet sind sowie einen zweiten npn- und pnp-Transistor auf entsprechend gegenüberliegenden Seiten, wobei besagte npn- und pnp-Transistoren auf entsprechend gegenüberliegenden Seiten so verbunden sind, daß die besagte Brückenschaltung gebildet wird, bei der die besagten npn- und pnp-Transistoren abwechselnd an- und abgeschaltet werden und wobei die besagten zwei Betriebssignale entsprechend an die beiden Eingangsklemmen der besagten Brückenschaltung angelegt werden und ein Gleichstrom zwischen deren Spannungsklemmen angelegt wird und so Plus- und Minus-Pulsspannungen mit einer Pulsruheperiode abwechselnd an deren Ausgangsklemmen erhalten werden, wobei das Ausgangssignal des besagten Inverters zwischen den Elektroden des besagten piezoelektrischen Vibrators angelegt wird.

Revendications

1. Pompe à vibrateur piézoélectrique comportant des vibrateurs piézoélectriques adjacents (2) montés dans un boîtier (1) ayant une partie périphérique fixée à une partie dudit boîtier, un clapet d'aspiration anti-retour (5) à travers lequel du fluide est aspiré dans un conduit d'aspiration (7) et un clapet anti-retour d'évacuation (6) à travers lequel le fluide est évacué dans un conduit d'évacuation (8) au moyen des vibrateurs piézoélectriques mis en vibration en appliquant une tension alternative entre des électrodes desdits vibrateurs piézoélectriques, lesdits clapets anti-retour d'aspiration et d'évacuation (5, 6) étant tous deux dans ladite paroi de boîtier et du même côté desdits vibrateurs piézoélectriques, caractérisée en ce que les vibrateurs piézoélectriques sont revêtus des deux côtés avec des couches d'élastomère élastique (10, 17) de 1 à 5 mm d'épaisseur, ayant un module d'élasticité longitudinal inférieur à 5 x 10^8 dynes/cm^2, ces couches d'élastomère élastique (17) qui se trouvent entre des vibrateurs adjacents (2) étant conductrices.

2. Pompe à vibrateur piézoélectrique selon la revendication 1, dans laquelle un film imperméable au liquide (18) est stratifié sur la surface de l'élastomère élastique (10).

3. Pompe à vibrateur piézoélectrique selon la revendication 1 ou 2, dans laquelle la couche d'élastomère comporte un élastomère choisi dans le groupe constitué par le caoutchouc silicone, le caoutchouc uréthanne, le néoprène, le caoutchouc nitrile-butadiène, le caoutchouc styrène-butadiène, le chloroprène, le caoutchouc au fluorure de silicone, et le caoutchouc d'éthylène-propylène.

4. Pompe à vibrateur piézoélectrique selon l'une des revendications 1 à 3, dans laquelle ledit conduit d'aspiration (7) et ledit conduit d'évacuation (8) sont pourvus chacun d'un réservoir d'égalisation (13, 14) ayant un espace (15, 16) au niveau d'une partie supérieure respective proche respectivement dudit clapet anti-retour d'aspiration (5) et dudit clapet anti-retour d'évacuation (6).

5. Pompe à vibrateur piézoélectrique selon la revendication 1, dans laquelle ladite pompe à vibrateur piézoélectrique comprend un inverseur ayant un circuit oscillateur (27) recevant une entrée à courant continu de sorte que l'oscillation à une fréquence donnée peut être produite et duquel sort une tension en forme d'onde, un circuit de commande (28) recevant une sortie provenant dudit circuit d'oscillation (27) et duquel sont entrés deux signaux de fonctionnement ayant des points de fonctionnement différents à des intervalles de période de repos et un circuit de génération d'impulsion (29) ayant des tensions d'impulsion positive et négative qui sont générées de manière alternée en fonction des deux signaux de fonctionnement délivrés par ledit circuit de commande (28), ladite pompe à vibrateur piézoélectrique étant commandée par la sortie dudit inverseur.

6. Pompe à vibrateur piézoélectrique selon la revendication 5, comprenant un inverseur, dans laquelle ledit circuit de génération d'impulsion (29) comprend un circuit en pont (30), ledit circuit en pont (30) comporte un transistor NPN et un transistor PNP disposés de manière respective sur deux côtés opposés et un deuxième transistor NPN et un deuxième transistor PNP disposés sur des côtés opposés, lesdits transistors NPN et lesdits transistors PNP sur des côtés opposés respectifs étant reliés de telle sorte que ledit circuit en pont est formé en ayant lesdits transistors NPN et transistors PNP qui passent de manière alternée dans des états passant et bloqué, les deux signaux d'actionnement étant appliqués de manière respective sur les deux bornes d'entrée dudit circuit en pont, un courant continu étant appliqué entre les bornes de tension de celui-ci et des tensions d'impulsion positive et négative avec une période de repos d'impulsion étant obtenues de manière alternée au niveau des bornes de sortie, la sortie dudit inverseur étant appliquée entre des électrodes dudit vibrateur piézoélectrique.

FIG. 1

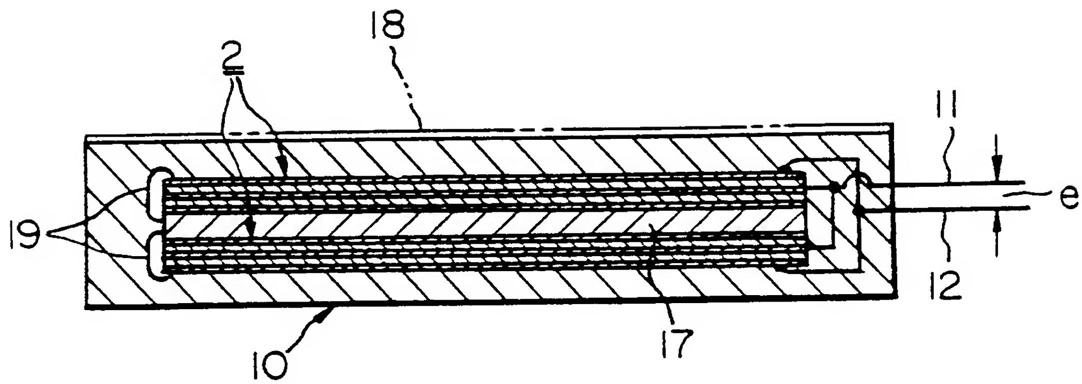


FIG. 2

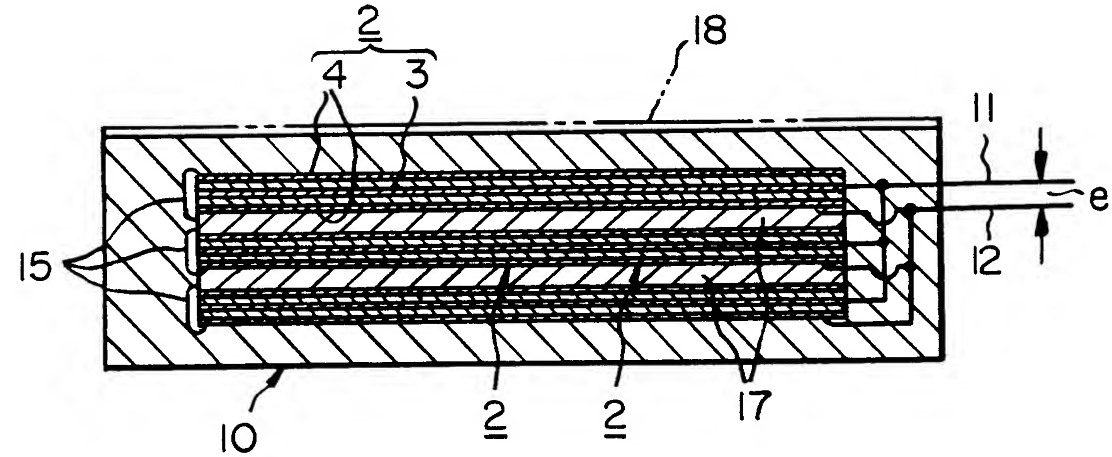
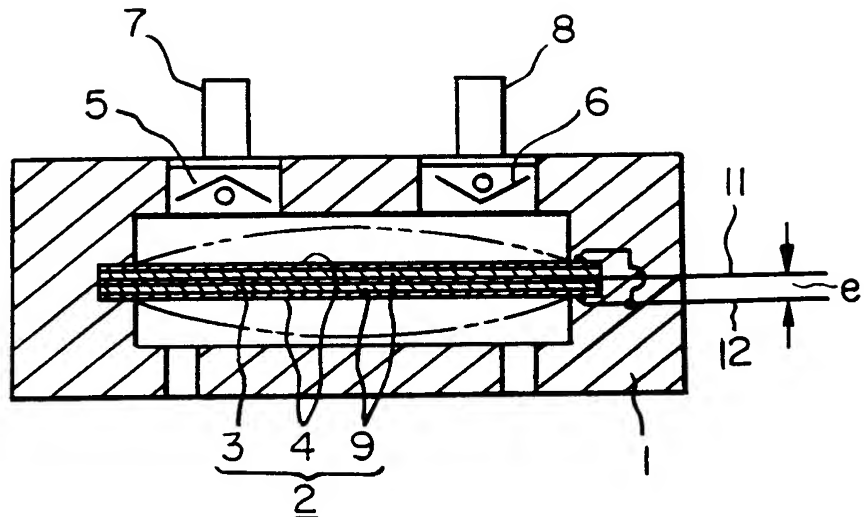
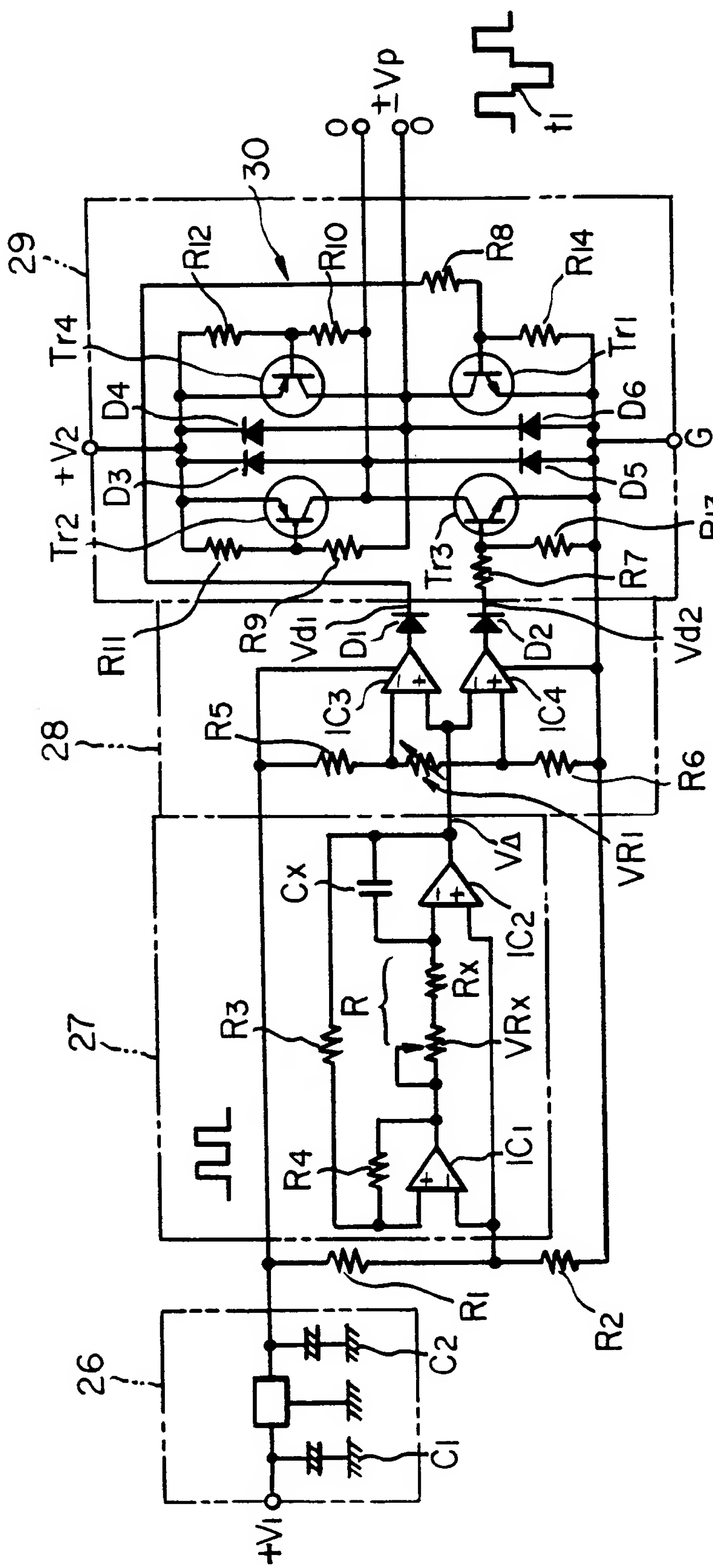


FIG. 4





26
27
28
29
30
+V1
C1
C2
R1
R2
R3
R4
R
Rx
VRx
Cx
IC1
IC2
IC3
IC4
VΔ
R5
R6
VR1
D1
D2
Vd1
Vd2
R7
R8
R9
R10
R11
R12
R13
R14
Tr1
Tr2
Tr3
Tr4
D3
D4
D5
D6
+V2
G
±Vp
O
t1

F I G. 3